The ice cream industry uses large amounts of milk fat stored as frozen cream. Refrigeration costs of this product are significant; and if a major portion of this expense could be eliminated, appreciable savings might accrue to ice cream manufacturers.

Recurring surpluses of butter emphasize the desirability of developing a dairy product of high fat content which, potentially at least, has a variety of uses and, if possible, the advantage of storage stability at room temperature or only a little lower.

A dairy product which promises to meet these requirements, is the subject of this paper.

A basic purpose of many dairy products is to preserve one or more milk components in a commercially attractive form. In order to preserve concentrated milk products, frozen storage or sterilization is necessary unless sufficient sugar is added to prevent the growth of microorganisms, as is done in sweetened condensed milk, a product which has excellent food properties and which keeps well during long periods of storage without refrigeration. Preservation with sugar avoids gross changes in milk flavor and in the physical state of the fat and protein.

Preparation

A product with high fat content and preserved with sugar can be made in four steps by a simple and economical process. The four steps are: 1) Preparation of a cream with high fat content; 2) addition to the cream of optimum amounts of nonfat dry milk (NFDM) to increase the stability of the emulsion; 3) addition of sugar to preserve the product; and 4) pasteurization. Each step can be varied in one or more details. A typical product contains about 40% fat, 32% sugar, 20% water, and 8% nonfat milk solids (NFMS).

As an example, 10 pounds of NFDM and 52 pounds of sugar are stirred into 100 pounds of cream containing 65% fat. This mixture is heated to 200° F., cooled by product to product regeneration, drawn into a vacuum chamber to remove air, and packaged with a minimum reincorporation of air.

Properties of the Product

The new product resembles sweetened condensed milk in appearance, flavor, and consistency. It is considerably less sweet because, with a milk solids content of about 50%, as compared with 28-30% for sweetened condensed milk, the water content of the cream product is lower and, consequently, less sugar is required to attain the sugar-in-water concentration (60-65%) necessary for self preservation. It reflects certain fat characteristics in its flavor, yellow color, and effect of fat crystallization on consistency. Since the fat content, ranging from 30% to 50% and preferably 40% to 45%, is approximately five times as great as in sweetened condensed milk, the product provides a means of preserving milk fat from a period of milk surplus to one of scarcity. Moreover, the saving resulting from the fact that sweetened modified cream can be stored at 50-60° F., rather than in frozen storage, is a major economic advantage.

Uses

Obvious uses for the new product are in ice cream, in bakery products, in coffee, in candy, and as a topping. Upon appropriate dilution with water it can be whipped just like the corresponding mixture of fresh cream and sugar. The flavor can be varied by the addition of small amounts of suitable flavoring agents. A product similar to the sample presented at this meeting, still had a satisfactory flavor after storage without refrigeration for six months.

TABLE: POSSIBLE COMPOSITIONS OF SWEETENED CREAM PRODUCTS

Those compositions to the left and right of the solid lines are not practical. Those in the middle section are practical products. Optimum composition is completely enclosed.

Ratio NFMS: F = 0.360 (as in cream with 20% fat)					
	%	%	%	%	%
Milk Fat	20	30	40		
NFMS	7.2	10.8	14.4		
Sugar	(45.9)	37.3	28.7		
Water	26.9	21.9	16.9		
NFMS in the water	21.1	33.0	(46.0)		
Ratio NFMS: F = 0.210 (as in cream with 30% fat)					
Milk Fat	20	30	40	50	(60)
NFMS	4.2	6.3	8.4	10.5	12.6
Sugar	(47.8)	40.1	32.5	24.9	17.3
Water	28.0	23.6	19.1	14.6	10.1
NFMS in the water	(13.0)	21.1	30.6	41.8	(55.5)
Ratio NFMS: F = 0.135 (as in cream with 40% fat)					
Milk Fat		30	40	50	(60)
NFMS		4.1	5.4	6.8	8.1
Sugar		41.5	34.4	27.2	20.1
Water		24.4	20.2	16.0	11.8
NFMS in the water		(14.4)	21.1	29.8	40.7
Ratio NFMS: F = 0.090 (as in cream with 50% fat)					
Milk Fat			40	50	(60)
NFMS			3.6	4.5	5.4
Sugar			35.5	28.7	21.8
Water			20.9	16.8	12.8
NFMS in the water			(14.7)	21.1	29.7

General Considerations

Although the mechanics of the making process are simple, care must be exercised in formulation, in sanitation, and in packaging, just as with other dairy products, particularly sweetened condensed milk. Molds, yeasts, and other microorganisms must be strictly controlled. Too-high storage temperatures are unfavorable to good keeping quality. They require a higher sugar-in-water concentration, such as 64 per cent instead of 61 or 62. Also, some extra NFMS may be necessary to increase the viscosity and thus minimize fat rising. Like sweetened condensed milk, the new product is subject to "age thickening" and to darkening when held at too high a temperature, but

to a lesser degree, probably primarily because of its lower protein content. Like sweetened condensed and evaporated milk, it is distinctly more stable when stored at 60° than at 80° F.

No fat separation has been found in samples that were stored at 60° F. But at 80° F., a temperature at which the sweetened cream is much less viscous, analysis has shown a fat content as high as 45 per cent in the upper half of samples made up to contain 40 per cent milk fat. All things considered, storage at 60° F. is an excellent way to retain a homogeneous emulsion.

Several possible compositions of products are listed in the table. The basic variables in formulation are the fat content of the cream and the amount of NFMS. The essential ratio NFMS: fat was varied. If the product is to keep satisfactorily, the amount of sugar in the water portion must always be not less than 60-65 per cent. This "sugar concentration" was fixed at 63% in the table. Three factors — too high fat content of the starting cream (examples on the right side of the table), the percentages NFMS in the water (NFMS percentages in parentheses in table) and excessive sweetness (sugar percentages in parentheses) — limit the practical composition of the product to the range in the center portion of the table. There is an optimum in the NFMS range: too low percentages of NFMS in the water result in insufficient viscosity to prevent fat separation; too high percentages of NFMS in the water cause too high a viscosity, and the product may become sandy due to lactose crystallization. The composition enclosed in solid lines in the table is about optimum for the simple procedure described.

Crystallization of lactose is not important if the product is to be used in the making of ice cream mix, since the crystals would dissolve in the mix. For other purposes, prevention of sandiness may be necessary. This can be done by decreasing the amount of added NFDM or, as in the manufacture of sweetened condensed milk, by accelerated crystallization in order to form small crystals of lactose or by the use of low-lactose dry milk, or by hydrolysis of lactose.

Prevention of fat separation is important; too high fat concentration in the top portion may result in oiling off. The unprotected and exposed fat is more susceptible to oxidation and development of a tallowy flavor than the rest of the fat in the container.

At a low level of NFMS, the viscosity can be greatly increased, and the emulsion stabilized, by means of homogenization. This is an effective way to avoid both fat separation and lactose crystallization at the same time. An additional advantage of homogenization is a decrease in the tendency of the product to churn when it is whipped. For certain applications these advantages may overcompensate the expense of carrying out this additional step. In our laboratory such a product and process call for homogenized sweetened cream containing 40% fat and 5-6% NFMS obtained in a continuous operation. This gives a composition only a little different from that enclosed in solid lines in the table. A product of the latter composition may become grainy when storage is of long duration. Higher fat contents are possible. Flavorwise a high level of NFMS seems to produce more stability than a low level.

Although excellent products have been prepared and packaged under atmospheric conditions, packaging the product with little air in it reduces the possibility of the development of off-flavor (tallowiness from fat oxidation) during storage. This can be accomplished by drawing the pasteurized,

but still hot, product into a vacuum chamber and then filling the cans or other suitable containers in such a way as to have a low level of oxygen in the product and a minimum of head space after the covers have been sealed in a vacuum or at atmospheric pressure. On cooling there will be a partial vacuum in the head space of each container. This will help to keep the air content at a low level.

The use of a friction-closure, straight-side, light-gauge, metal container of 100 pounds capacity has been suggested.

Public service patent applications have been made for the product and process.